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Not what anyone wanted: Observations on regulations, standards, quality and experience in the wake of Grenfell

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Introduction

While many factors will have contributed to the catastrophe at Grenfell Tower, it is clear that the structure itself behaved in a way that no one could possibly have intended. In this article the authors sample the bewildering and sometimes apparently contradictory directions provided by building regulations, and review how fire safety precautions, while seeming adequate on paper, can be undermined on contact with observed on-site practice.

Main text

The standards and regulations of the UK construction industry are highly regarded internationally but the Grenfell Tower fire has called into question the industry's procedures, their enforcement and the quality of UK construction. The events of 14 June 2017 led to an unprecedented loss of life. Without second guessing the enquiry, there are some obvious problems: the external facing materials including the cladding combusted too easily, the fire spread rapidly both vertically, laterally and through the building, there was little resistance to the spread of fire and it was difficult to extinguish. Almost every aspect of the industry's safeguarding regulations and procedures appear compromised or overlooked. With hundreds of buildings considered to be at risk and the many cladding systems now condemned, it is evident that the industry is either unaware of the regulations and standards that apply or is neglecting responsibility for fire safety. Questions must be answered and the tragedy of Grenfell must be acknowledged to restore confidence in industry standards and processes.

With hindsight, we would require clarity on where site practices differed from the regulatory requirements. However, a review of the regulations is at best confusing and some parts of the Approved Documents are misleading. Without forensically picking apart the regulations and reassembling them into a more intelligible form, it is doubtful whether the parties were aware of what standards they should be building to.

The Building Regulations with their schematics and practical statements use legal language when citing and cross-referencing supporting documents and standards. While general assumptions can be made, understanding the full implications of the approved documents requires access to reports and standards that may not be immediately available to most construction professionals. This is a real concern as building regulatory controls were set up for the industry, not lawyers, to ensure events such as Grenfell should not occur. Building regulations originated from a need to control the spread of fire; unsurprisingly, the London Building Act 1667 was introduced to avoid a repetition of the Great fire of 1666. This Act provided the basis for the initial regulations, with the overwhelming need to control the threat and spread of fire and smoke in buildings. However, building processes, products and legislative frameworks change and are always under review to ensure they safeguard occupants. The Grenfell fire has drawn attention to the fact that the regulations do not provide an intelligible message. Notwithstanding changes in building regulations, evidence from other recent events should have provided an impetus for change. The industry has become blind and in some

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cases has ignored the lessons which should have been learned.

While many factors will have contributed to the catastrophe at Grenfell Tower, it is obvious that the cladding and external insulation burned much more readily than many would have expected. The Building Regulations are clear on this point:

“12.5. The external envelope of a building should not provide a medium for fire spread if it is likely to be a risk to health or safety. The use of combustible materials in the cladding system and extensive cavities may present such a risk in tall builds. External walls should either meet the guidance given in paragraphs 12.6 to 12.9 or meet the performance criteria given in the BRE report Fire performance of external thermal insulation for walls of multi storey buildings (BR 135 for claddings systems using full scale test data from BS 8414-1:2002 or BS 8414-2005).”

While, Diagram 40, Approved Document B, vol. 2. “Provisions for external surfaces or walls” (DCLG, 2013) shows a set of drawings that includes the use of UK regulation Class O (a material or product which is non-combustible or material of limited combustibility), we are also mindful that paragraph 12.5 discusses the use of combustible materials and allows for use where tests have been undertaken and risk of fire spread is reduced. In the Building Regulations Diagram 40, Class O or the class B-s3, d2 or better can be used on buildings above 18 metres. It is worth noting that Class B refers to tests that limit the spread of fire (flames) under a limited exposure to flame attack.

Under surface flame attack and, where required, edge flame attack (see 6.3) with 30 seconds exposure time, there shall be no flame spread in excess of 150 mm vertically from the point of application of the test flame within 60 s from the time of application BS EN 13501-1:2007 + A1:2009 (2009) p21, 11.6).

In this paragraph no reference is made to non-combustible or limited combustibility and the sub-classifications s3 allows unlimited smoke production and d2 is the lowest classification for fire droplets thus “…there is no limit set for smoke production and/or flaming droplets/particles” (BS EN 13501-1:2007 + A1:2009 (2009) p34).

From a rather confused review of the regulations it would seem that Class O restricts materials to limited combustibility, above 18m, but the European Standard or British Standard European Norm (BS EN), given as an alternative, only limits the spread of flame for a relatively restricted period. There emerges a difference between materials that may satisfy the test and assemblies, and building conditions that could affect the health or safety of the occupants.

From experience we know that combustible materials are a problem even when protected with a less flammable finish. Many investigations have been carried out to demonstrate what happens in a fire and how it develops. Particularly notable was the Dublin Stardust fire in 1981, and the BRE reconstruction. This reconstruction was set up as the seat coverings were shown to be combustion-resistant but, when split, the underlying upholstery was not. In the reconstruction, with the carpet-tile wall coverings, the fire developed with terrifying speed and became rapidly uncontrollable (this can be witnessed on you tube footage: “Stardust disco 1981”). In the actual fire 48 people lost their lives and in the fire reconstruction the speed with which it developed caught the research team by surprise, evidenced by their great haste in evacuating the open-sided test facility, which was totally engulfed within minutes. While Stardust was an internal fire, it was evident that once sufficient time is allowed for a small fire to develop and the radiative heat be reflected and channelled, combustible material in the vicinity can quickly ignite. The conditions of a building are often quite different from the laboratory tests.

In the more recent Lakanal House disaster of 2009 fire originated from a faulty television on the ninth floor and spread unexpectedly quickly, both laterally and vertically, combusting the cladding and travelling between apartments. Specifically, the cladding, made up of composite panels in the window sets, was not required to be fire-resistant (Greater London Coroner's court, 2013) which meant that the panels combusted within a few minutes. This was a refurbishment project, as was Grenfell, where a key question is whether the retrofit compromised the building's fire safety.

With retrofits or remediation it is even more important to ensure the installations and builders' work do not compromise the building's integrity and fire safety. In Lakanal, building defects, the lack of effective seals, fire stopping, and broken compartmentation contributed to the spread of fire and smoke and the ultimate death of six people. In 2017, Southwark Council pleaded guilty to four charges concerning breaches of safety regulations, incurring a £270,000 fine plus £300,000 costs. The enquiry showed that the lack of fire-resistant cladding was not among the counts for which they were culpable, however it was clear that the standards required were not sufficiently stringent.

In a series of recent high-rise fires in Dubai, there occurred rapid fire spread up vertical faces through the polyurethane and aluminium cladding. Examples include the 82-storey Torch Tower, the 75-storey Sulafa Tower and the 63-storey The Address Downtown Dubai Tower. Of interest is that there were no fatalities in any of the buildings. In The Address building, the fire was presumed to have started with an electrical fault that spread through the window construction to the cladding, similar to Grenfel. The buildings were relatively new and the fire was contained, with damage restricted largely to the cladding. Thus, although such combustible cladding materials are questioned, where the passive integrity of the building is sustained the potential for safe evacuation can be maintained.

The recent action to remove combustible cladding from tall buildings is clearly right. The Scottish Parliament acted more swiftly than England to ensure that external cladding "inhibited" fire spreading. The Building Regulations changes introduced in 2005 followed a fatal fire in a Scottish tower block in 1999. Following of Grenfell some changes to the regulations with regard to combustible materials in construction are likely, but the passage of fire across the face of the cladding and through the building was also a result of inadequate barriers and compartmentation. The quality of on-site construction and alteration is not adequately addressed in the Building Regulations.

Photographs (e.architect, 2017) of the cladding system at Grenfell and some construction details around the windows raise important questions about the adequacy of fire barriers and stops at each floor and junction. In the real world, refurbishment and cladding retrofits can undermine fire safety design precautions. With retrofit projects, drawings can address "typical construction", leaving the final "detailing" to the original structure's irregularities and difficult junctions to the trades and those installing the cladding systems and fire barriers. It is crucial to be on guard against gaps between the insulation and main construction.

Combustion, cladding and tower blocks

There is much to learn from Grenfell. First we must remember that for combustion to occur we require fuel, a source of heat and a supply of oxygen. Fire testing can furnish useful data about whether or not material is combustible; heat produced by complete combustion per unit weight of material; speed of surface spread of flame; and chemicals produced and emitted during combustion.

However, the application of fire test data to real situations is not a straightforward matter. Testing single samples of material can be limited in what it reveals and it is usually better to test materials in the combinations in which they are actually used. This is the philosophy behind the latest fire testing methods. The location and geometry of the material has an important bearing. In the case of Grenfell Tower, cladding and insulation material was applied to external vertical surfaces on a 67-m-high building.

Should any external material catch fire, the hot gases produced by combustion will rise due to natural buoyancy, thereby facilitating the rapid vertical spread of heat and flame. Behaviour of the hot gases passing over the surface is governed by the Navier-Stokes equation. Whenever a fluid – liquid or gas – contacts a solid surface, a boundary layer of fluid attaches itself to the solid. The forces of molecular attraction then ensure that any moving fluid layer will be drawn close to the surface: the external wall in the case of the Grenfell Tower. With intense heat close to the wall, any combustible material will be readily ignited.

The most widely used principle of passive fire protection is that of compartmentation, that is, confining the fire to the room or enclosure of origin. Since smoke is the main killer in building fires, compartmentation should also prevent the spread of smoke. This strategy involves fitting fire doors to all rooms with the necessary fire endurance, usually at least 30 minutes. Such containment allows the occupants adequate time to escape. Windows represent an area of weakness as glass can shatter due to thermal shock. Equally, remedial builder's works that do not leave effective seals will compromise compartmentation. If this happens there is then an opening produced through which hot gas and flame can exit. If this happens, it is essential that there is no combustible material on the outside of the building envelope, otherwise rapid vertical spread of flame will ensue.

In Grenfell Tower, the insulation layer was fitted to the outer concrete wall, and there was an air gap between the insulation and the outermost aluminium panel. In this situation it is vitally important that any combustible material is protected from contact with heat or flame that may issue from a breached window opening. The method of doing this is fire stopping and, to be effective, it must be 100% complete: even small gaps will enable the passage of flame and hot smoke.

Insulation material necessarily has a very low thermal diffusivity and, if ignited, burning would be prolonged. Given the thickness of the layers of insulation applied to Grenfell Tower, the burning time would be measured in hours. Indeed, once alight, it would be difficult to extinguish and this was what was observed in this particular fire. The fire began in the middle of the night but was still well alight the next morning as the television news footage clearly showed. The combination of combustible material, an air gap and incomplete fire stopping proved to be fatal.

In addition, experience with tall buildings in the USA has shown that active fire protection in the form of sprinkler systems are more effective in checking fire spread than the attendance of numerous fire engines. Providing that compartmentation measures and sprinklers are installed, then the advice to stay in your room would be sensible. In the Grenfell Tower, this advice was not appropriate. The Piper Alpha oil rig explosion and fire demonstrated that adherence to the instructions proved fatal; those who ignored it were saved and those who obeyed perished. If the circumstances of fire differ from those anticipated by the building designer, instructions on how to behave in a fire may be wrong.

Fire deaths should be prevented by adherence to and enforcement of the Building Regulations pertaining to fire safety, and when it comes to fire stopping, attention to detail is all-important, as a small breach can prove to be fatal. With tall buildings, the ease with which flame can spread vertically makes it imperative that any insulation and cladding is absolutely non-combustible. There is much to learn from Grenfell and whole industry will be minded to adopt changes that do not let this happen again.

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